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Innovation Measurement – A Comparative Analysis between Innovation Measurement Literature and Innovation Measurement tools.

João Miguel Pizarro Martins (30711)

A Project carried out on the International Master in Management Program, under the supervision of:

Professor Aníbal López

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Abstract

Innovation is paramount for organizations as a primary source of competitive advantage. It is crucial for organizations to measure and quantify their innovation level in order to optimize resource allocation. There are several tools aimed to evaluate the innovation level of organizations. However, these tools lack some internal validity due to their misalignment with recommendations from research. The present thesis is a comparative analysis between the recommendations from the literature on innovation measurement and the structure of the main tools used for measuring innovation in organizations. Our findings propose recommendations for further improvement of these tools.

Keywords: Innovation, tool, measuring, comparative analysis;

1. Introduction

Innovation is of vital importance for the assurance of companies' survival. Managers now realize that without proper innovation efforts the probability of failure increases (Eveleens, 2010). The availability of relevant innovation metrics is crucial for establishing a comparison against competitors, to benchmark the results against market standards and as well to align internal efforts for innovation. Governments also benefit from promoting the implementation of innovation evaluation practices, as it will result in the understanding of the local economic reality and will contribute for the increased accuracy of public policy formulation (Lacerda, 2017). Therefore, measuring innovation is a significant cornerstone in order to establish innovation promoting behaviors and policies for organizations and society.

Several innovation measurement tools have been developed to allow managers to assess the innovation level of organizations. As some of these tools lack internal validity, they might not be able to provide the necessary information for organizations to adapt their innovation strategy, which might, in turn, compromise the organization's outcomes.

The present thesis aims to evaluate the adequacy of several innovation measuring tools. Specifically, we performed a comparative analysis of several well-known measuring innovation tools with the Multi-Dimensional Framework of Organizational Innovation developed by Crossan and Apaydin which was published in 2010. This analysis brings contributions to both theory and practice. For theory: as we find patterns and misalignments between literature recommendations and the structure of innovation measurement tools, we are opening new paths for further research on the field of innovation; for practice: as we propose improvement for the innovation measurement tools, we are contributing to an increase in the competitive capability of companies as tools are able to measure accurately and contribute to a better resource allocation for innovation. As we promote alignment between the different published frameworks and tools regarding the evaluation metrics, we are contributing as well to a decrease in skepticism towards innovation practices.

2. Literature Review

What is Innovation?

Innovation is recognized to be the main catalyst for organizational efficiency and competitive advantage (Urabe, 1988). The study of innovation is not new; however, there is no agreement on a standard definition (Kogabayev & Maziliauskas, 2017). Several definitions of innovation have been stated in the literature. For instance, Cooper (1998) defines innovation as a tri-dimensional

relationship between product/process, Incremental/radical and administrative/technological axis, Drucker (1985) defines innovation as an entrepreneurial tool used in order to exploit opportunities, while Schumpeter (1983) states that innovation is the impact of the employment of existing productive capabilities in order to solve new business problems. The previously stated definitions highlight different aspects of innovation, and as innovation and measuring it are transversal topics through all organizational dimensions, a holistic definition of innovation is believed to be adequate. Therefore, the definition used in this thesis resulted from a systematic review of the literature on innovation published between 1983 and 2010, conducted by Crossan and Apaydin which was published in 2010 in the Journal of Management Studies. Their definition states the following:

"Innovation is production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services and markets; development of new methods of production; and the establishment of new management systems. It is both a process and an outcome" (Crossan & Apaydin, 2010).

Why is it important to measure innovation?

"It's war: Innovate or die."

(Cooper, 2005).

In an environment characterized by a rapid technological improvement, the risk of becoming obsolete tends to increase accordingly. Innovation, as a source of competitive advantage, needs to be assessed, measured and turned into something intrinsic into the organizational DNA in order to allow the organization to cope with the hard market reality.

Since innovation is regarded as a significant catalyst for competitive advantage, companies commit themselves to invest heavily in order to be innovative. Measuring innovation is therefore paramount for organizations as it allows them to account for the level of success of their investments (Haar, 2018). Several tools are being used in order to evaluate innovation, and as each of them requires different levels of data availability, each company tends to use the tool that better suits their innovation objectives and their resource availability. (Haar, 2018).

Nations also depend on innovation in order to achieve sustainability. (Oladele-Emmanuel et al., 2018). The reality organizations and countries are facing nowadays, is one of fundamental change in what concerns the technological paradigm (OECD, 2005). It is therefore crucial for countries to obtain data on how innovative their companies are in order to promote better resource employment and correct policy development.

3. Methodology

Our study is aimed to compare what is stated in the literature on innovation evaluation metrics and the structure of innovation measurement tools, in order to find discrepancies and to develop further recommendations. As a theoretical framework and comparative reference, we will use the one built by Crossan and Apaydin, published in the Journal of Management Studies in 2010. Resultant from a systematic review of the literature the study originated meta-theoretical constructs containing a set of innovation actionable determinants which are therefore believed to be the most consensual amongst the innovation measuring literature.

In order to select the innovation measurement tools to be analyzed in this thesis we proceeded to do the following: first, we searched in scientific databases available at Nova School of Business

and Economics library online resources, through search engines such as Google Scholar and EBSCO, papers based on keywords like "Innovation determinants", "Innovation measuring", "Innovation measurement tools" and "Innovation controlling". Based on this primary research we were able to identify 34 innovation measurement tools. After this first research we proceeded to exclude 25 tools based on the two following criteria: (1) Exclude the ones focused on national level innovation measurement; (2) Exclude the tools focused on specific intra-organizational dimensions, such as "team innovativeness" or "project innovativeness." We were then able to focus on organizational-wide innovation measurement tools. Based on our research methodology and selection criteria nine tools were identified. Out of this nine, only on six of them we were able to collect information in order to perform the comparative analysis: Innovation Scoring by COTEC Portugal; Taking the measure of your innovation performance by Bain & Company; I-SCORE, Innovation Scorecard for Business Excellence; Input-Process-Output-Outcome Model (IPOO); Determinants of Innovative Ability and Community Innovation Survey.

4. Results

4.1 Comparative Analysis

We conducted a comparative analysis between the framework of Crossan and Apaydin (2010) and the selected tools. We used this analysis methodology because it allows for the identification of patterns or flaws, facilitates the construction of categories, and eases the overall information organization (Beije, 2002; Tesch, 1990).

The multidimensional framework on Organizational Innovation built by Crossan and Apaydin (2010) resulted from a systematic review of 525 papers on the topic ‘innovation’ (after filtering

and excluding duplicates from the initial pool of 10 946 papers). There were identified a set of determinants which were organized into three macro-categories: Innovation Leadership, Managerial Levers and Business Processes. The reasoning behind this division is the following:

"Leaders implement ***deductive innovation strategies*** *(Regnér, 2003) through* ***direct (managerial) levers*** *such as* ***decisions and actions*** *taken by leaders to deliver innovation. Senior executives exercise* ***indirect leadership*** *(Jansen et al., 2009) to guide innovation champions at the middle management level in their implementation* ***of Business Processes*** *that support innovation."* (Crossan & Apaydin, 2010).

Each of the macro-categories is composed by a set of actionable determinants that have a direct impact on the promotion of innovation in an organization (Appendix 1). For each of the determinants, there were identified a set of accessing measures. The determinants and the respective measures proposed by Crossan and Apaydin (2010) were compared against the six innovation measurement tools (Appendixes 2, 3 and 4).

From this point onwards, we will discuss the comparative analysis' results. It is important to clarify that the coincidence of criteria is not linear; therefore, there are points of coincidence which are not expressed in the same words, and it might be subject to different interpretations.

Tool 1 - Innovation Scoring by COTEC Portugal.

The Innovation Scoring by COTEC is an innovation measurement tool, which consists of 30 questions: nine regarding Strategy, seven regarding Organization, three regarding Research Development and Innovation practices, five regarding Enablers and six regarding Impact. As table 1 demonstrates the tool is divided into five macro-categories which are further sub-divided:

Macro Categories	Strategy	Organization	R&D&I Processes	Enablers	Impact
Sub-divisions	Environmental analysis	Structure and governance	Idea's generation and evaluation	External Affairs	Market
	Strategic planning	Human Capital	Project management	Financing	Sustainability
	Culture and leadership	Organizational competencies	Protection and appreciation of intellectual property	Knowledge management	

Table 1- Macro organizational categories and respective sub-divisions for innovation evaluation (Innovation Scoring, 2017).

Starting with the first category: Innovation Leadership. There were not found any coincidences in what comes to collective leadership characteristics, and the ones found on individual characteristics such as Tolerance to ambiguity, Openness to experience, Originality, Rule Governess, Proactivity and Managerial tolerance to change had to be inferred, as they derive from evaluated managerial behaviors.

Regarding Managerial Levers, there is a coincidence in the determinants present in the framework of Crossan and Apaydin (2010) and the ones used in Innovating Scoring. Dimensions such as Mission, Goals, and Strategies, Resource Allocation, fostering a Learning Environment, Knowledge Management and the importance of Organizational Culture are considered in the tool. However, Managerial Levers such as Structure and System Factors in which the framework emphasizes the importance of measuring Specialization and Centralization (Damanpour, 1991; Zaltman et al., 1973), Formalization (Damanpour. 1991; West et al., 1998), Stratification (Kanter, 1983), and the Number of Employees (Rogers, 1983), as well as Organizational Climate Attractiveness are not considered.

As it was stated earlier, as a result of the application of Managerial Levers specific Business Processes are established to support innovation. Business processes can be regarded as a set of internal activities and behaviors that, when performed systematically and using the same inputs, will result in a constant, predictable outcome (Crossan & Apaydin, 2010). In the framework, these

Business Processes include Initiation, Portfolio Management, Development and Implementation, Project Management and Commercialization (Crossan & Apaydin, 2010).

When comparing COTEC's Innovation Scoring tool and the framework, it was observed coincidence in processes such as Initiation, Implementation, Project Management, Project Efficiency, and Commercialization. However, Business Processes such as Portfolio Management with accessing measures such as Constrained optimization to maximize output (Schmidt & Freeland, 1992), Usage of optimization tools (Cooper et al., 1999, 2001) and Formalized process of project selection (Cebon & Newton, 1999) are not considered in the tool.

What we consider to deserve further analysis:

- The way leaders promote innovation transmits individual characteristics denoted as being important in the framework of Crossan and Apaydin (2010). One example to explain this: by fostering a learning environment where, workers are incentivized to take risks and make mistakes, leaders are already demonstrating characteristics such as tolerance to ambiguity (Barron & Harrington, 1981; Patterson, 1999), tolerance to change (Damanpour, 1991) and openness to experiences (George & Zhou, 2001; Patterson, 1999; West, 1987);
- On Innovation Scoring the resource allocation is focused on R&D&I projects, whereas in the framework of Crossan and Apaydin (2010) it is analyzed in a broader company-wide view;
- The tool has human resource related determinants in the Culture and Leadership section. Considering the impact that human resource management has on Innovation (Laursen & Foss, 2003), this section requires further improvement and completion in the tool;
- The tool does not mention the importance of involving clients on the information loop, regardless of the literature stating its importance (Lee et al., 1996);
- There's room for distinction between knowledge and portfolio management on the tool;

Tool 2 – Taking the measure of your innovation performance by Bain & Company

In order to develop a tool that would measure innovation, Bain & Company through the work of Almquist, Leiman, Rigby, and Roth surveyed nearly 450 executives around the world at enterprises with more than $100 Million in revenue. Through the completion of this work in 2013, Almquist et al. concluded that "innovation leaders consistently outperformed laggards on **five manageable** capability areas." This tool was build based on the following manageable areas:

Areas	**Strategy**	**Organization**	**Idea generation and development**	**Portfolio management**	**Scaling**
Sub-divisions	Goals and strategies	Both brain talent	Idea generation	Portfolio Management	Scaling and launch strategy
	Strategic Alignment	Structure	Idea Screening and development	Project Management	Feedback loops and adaptation
	Culture and leadership	Roles and decision making	Prototyping and testing		
		Culture			

Table 2 - Five Manageable areas and respective sub-divisions for innovation evaluation (Taking the measure of your innovation performance by Bain & Company, 2013).

One concept that is consistently applied in this tool is the one of "BothBrain." It results from the belief that in order for innovation to take place it requires both the brilliant ideas that will give origin to innovative outcomes and the capacity to commercialize them (Almquist et al., 2013).

Starting the comparison by the Innovation Leadership construct: its importance is stated explicitly on the tool.

Regarding Managerial Levers, there's a coincidence of determinants between the framework of Crossan and Apaydin (2010) and the tool at a macro level, as the coincidence in specific innovation determinants had to be inferred. Considering the example of fostering a Learning Environment: There is no specific concern with accessing measures such as the adoption of risk-taking norms (King et al., 1992; West & Anderson, 1992), nor the existence of a tolerance environment towards

failed ideas (Madjar et al., 2002). The tool mentions the need to well manage partnerships with creative people and business executives, inside and outside the organization, which from we can infer the existence of a concern with the promotion of a proper learning environment. Both the framework and the tool recognize the necessity of aligning Mission, Goals, and Strategies with the innovation objectives. Regarding Resource Allocation, the tool focuses on the way resources are directed to allow promising projects to be installed and scaled. The tools find coincidence with the framework of Crossan and Apaydin (2010) as well on the following Managerial Levers: Structure and System Factors, and the concern with Organizational Culture for innovation promotion. However, the tool does not consider Managerial Levers such as the presence of Knowledge Management Systems nor Organizational Climate Attractiveness.

Regarding Business Processes there is overall coincidence between the framework of Crossan and Apaydin (2010) in the following processes: Initiation, Portfolio Management, Implementation, Project Management, and Commercialization.

What we consider to deserve further analysis:

- The tool does not consider the importance of measuring Organizational Climate Attractiveness, through the application of Organizational climate scales (Amabile et al., 1996; Anderson & West, 1998) or evaluating Job satisfaction and group cohesiveness (Keller, 1986);
- Linkages with Universities (Atuahene-Gima, 1995) are not considered on the tool, and neither is expressed the need for Formal Information Gathering systems (Oliver et al., 1999);
- The tool does not dive deep into more specific determinants or enablers of innovation.

Tool 3 – I-SCORE, Innovation Scorecard for Business Excellence

Developed by Singapore Innovation Class, with the last available edition published in 2010 this framework considers several dimensions of the organization in order to perform the innovation evaluation. The six macro dimensions considered as relevant for the evaluation are:

Macro	Sub-division				
Leadership	Senior Leadership			Organizational Culture	
Planning	Strategy development & Deployment				
Information	Management of Information and Knowledge		Comparison & Benchmarking	Comparison & Benchmarking	
People	Human Resource Planning	Employee Engagement	Employee Learning and Development	Well Being & Satisfaction	Performance & Recognition
Processes	Innovation Processes	Process Management & Improvement		Supplier and Partnership Management	
Result	Customer Results	Financial & Market results		People Results	Operational Results

Table 3 - Six Macro Determinants and respective sub-divisions for innovation evaluation (I-SCORE – Innovation Scorecard for Organizational Excellence, 2013).

In what comes to Innovation Leadership, the I-SCORE tool focuses on senior leadership's capabilities to develop innovation-focused values, the reinforcement of this same values and to guarantee the organizational commitment. Therefore, we implicitly associate characteristics such as the determination to succeed (Amabile, 1983) and personal initiative (Frese & Zapf, 1994) to the leader that commits to reinforce an organizational-wide innovation vision.

Regarding Managerial Levers there is a coincidence in the following dimensions: Mission, Goals, and Strategies, Resource Allocation, fostering of a Learning Environment, establishment of Knowledge Management Systems, concern with Organizational Culture for Innovation and as well consideration for the Organizational Climate Attractiveness. However, the tool does not contemplate any mention considering Structure and System Factors as a Managerial Lever.

Considering Business Processes, we identified coincidence in the following processes: Initiation, Implementation, Project Management, and Commercialization. However, we are not able to find a coincidence in processes such as Portfolio Management and Project Efficiency, regarded as paramount on the Framework of Crossan and Apaydin (2010).

What we consider to deserve further analysis:

- There is no further mention of specific accessing measures such as the existence of slack resources (Damanpour, 1991; O'Brien, 2003) or R&D intensity (Parthasarthy & Hammond, 2002).
- There is no concern regarding determinants evaluating Structure and System factors such as evaluation of Organization complexity and Administrative intensity (Damanpour, 1991), Formalization (Damanpour. 1991; West et al., 1998) or Stratification (Kanter, 1983);
- Even though there is no specific mention on the determinants regarded as essential to assess Portfolio Management capabilities stated in the framework of Crossan and Apaydin (2010), the tool mentions the importance of reviewing the management of innovation projects, the necessity to assess the risk related to innovation and to protect innovation projects;
- It lacks in the tool mechanisms such as problem finding cycles (Bessant. 2003);

Tool 4 - Input-Process-Output-Outcome Model (IPOO)

This tool, differently from the ones previously compared is mostly focused on quantitative variables. Therefore, the coincidence regarding determinants is lower. However, we could not ignore such methodology as it might provide valuable insights. The tool is focused on various

phases of the implementation process of innovation, identifying quantitative and semi-quantitative variables on each of the 4 phases: **Input, Process, Output,** and **Outcome.**

	Quantitative variables				Semi-Quantitative variables	
Input	Personal Costs	Training costs per employee	Number of ideas		Work Experience of employees	Quality of the ideas
Process	Hours worked per project	Number of results achieved in time			Product/Service quality	Product/Service progress
Output	Number of patents	Number of new products	Average cost per patent		Synergy Effects	Fundamental research results
Outcome	Increase in sales/profit	Cost reduction			Product Improvement	Customer satisfaction

Table 4 - IPOO model: Variables for innovation Measurement (on "Measuring innovation: A State of the science review of existing Approaches.", 2018)

There are no coincidences regarding Innovation Leadership determinants. Regarding Managerial Levers, there is a shared concern with Knowledge Management systems as the tool considers the need for Fundamental research results which is aligned with the need for Formal Information Gathering processes (Oliver et al., 1999). The tool emphasizes as well the concern with Customer Satisfaction aligned with the framework's concern on evaluating Customer contact frequency (Lee et al., 1996).

The majority of the coincidence, and considering the quantitative nature of the tool, happens regarding Innovation Business Processes. Processes such as Initiation, Project Management, Project Efficiency, and Commercialization can be inferred by the dimensions stated in the tool.

What we consider to deserve further analysis:

- The quantitative nature of IPOO might complement the theoretical framework developed by Crossan and Apaydin (2010);

Tool 5 – Determinants of Innovative Ability

This tool resulted from the work of J. de Jong, R. Kemp, and C. Snel, published in 2001, who attempted to understand the determinants responsible for the innovation stimulation in companies.

From their work, resulted in a set of macro determinants and a subsequent set of characteristics which influence the company's ability to innovate: **People Characteristics, Strategy Culture, Structure, Availability of means, the performance of Networking Activities and Market Characteristics**.

In the tool, there is no explicit emphasis on Leadership as a determinant for innovation. We can, however, infer characteristics of the leader that fosters a risk-taking environment, as someone who is tolerant to change (Damanpour, 1991), and open to experiences (George & Zhou, 2001; Patterson, 1999; West, 1987).

Regarding Managerial Levers, we found coincidence in the ones such as Mission, Goals, and Strategies, fostering of a Learning Environment, the establishment of Knowledge Management Systems and concerns regarding Organizational Culture towards innovation. However, there is no mention in the tool regarding Resource Allocation, Structure and System Factors nor Organizational Climate Attractiveness.

Considering Business Processes: We were not able to find a relevant coincidence between the tool and the framework of Crossan and Apaydin (2010) besides Project Management concerns.

What we consider to deserve further analysis:

- The fact that the way employees are organized within a structure is different from the way a structure is designed to accommodate employees;

- Besides not emphasizing the importance of establishing Business Processes for innovation, the tool mentions the importance of the Market characteristics for the success of innovation, as demand and competition might impact the outcome of the efforts made to innovate.

Tool 6 - Community Innovation Survey

Focused on the premise that innovation can fail, this tool was created in order to collect information through the performance of questionnaires regarding two periods to account for the evolution of innovation practices and outcomes.

This survey is focused on a set of different dimensions: General Information, Product Innovation, Process Innovation, Ongoing or Abandoned Innovation activities, Activities and expenditures for Product and Process Innovation, Public Financial Support to Innovation activities, Co-operation for Product and Process Innovation activities, Organizational Innovation, Marketing Innovation, Public Sector Contracts and Innovation, Intellectual property rights and licensing and Basic Economic Information about the enterprise.

We will proceed to compare the categories present in the framework with the evaluative tool. Starting with Innovation Leadership: there is no question on the survey regarding specific characteristics of either the individual leader or the Top Management Team.

Considering the different Managerial Levers: there is a shared concern about the way resources are allocated, on fostering a Learning Environment and on establishing Knowledge Management Systems. However, the tool does not mention the following Managerial levers regarded as paramount in the framework of Crossan and Apaydin (2010): Mission, Goals, and Strategy, Structure and System factors, Organizational Culture and Organizational Climate Attractiveness.

Regarding the presence of Business Processes towards innovation, there's a coincidence on the importance given to the capability of Initiating an Innovation Process, to Portfolio Management capabilities and Commercialization competences. However, Implementation, Project Management, and Project Efficiency capabilities are not considered in the tool being analyzed.

What we consider to deserve further analysis:

- The tool goes beyond public organizations, focusing as well on external relationships established with other organizations and enterprises in order to promote knowledge creation;
- It is considered in the tool the possible innovation spillovers that might result from the fact that a company might be part of a group, and therefore might benefit from that.

5. General Discussion

5.1. Overview

The work developed allowed us to understand that there is still room for the establishment of a widely accepted tool, or a framework to measure innovation in organizations. We observed during our analysis that: (1) No tool had coincidence with the framework of Crossan and Apaydin (2010) in all the determinants; (2) Even though the framework of Crossan and Apaydin (2010) states the importance of the characteristics a leader and a leadership team should possess, only on two out of the six tools analyzed we found determinants connected to leadership; (3) There is an overall agreement over the importance of fostering a 'Learning Environment', possessing 'Knowledge Management Systems', establishing 'Initiation' processes, having 'Project Management' and 'Commercialization' capabilities, as there is coincidence with the framework of Crossan and Apaydin (2010) in 5 out of the 6 tools analyzed.

5.2. Recommendations for innovation tool's further development

The comparative analysis allowed for an identification of both coincidences and mismatches between the framework of Crossan and Apaydin (2010) and the tools analyzed. Therefore, there are a set of recommendations that we consider to be of vital importance in order to contribute to the improvement of scientific work on Innovation measurement.

Regarding Innovation Scoring by COTEC: (1) The high emphasis posed on R&D&I in terms of resource allocation narrows the view of an organizational-wide perspective and should, therefore, be improved; (2) The tool should include assessment measures of Organizational Climate Attractiveness (Laursen & Foss, 2003) given its impact on innovation; (3) There's room for the distinction between Portfolio Management and Knowledge Management (Crossan & Apaydin, 2010);

On Taking the measure of your innovation performance by Bain & Company: (1) There are no specific or actionable determinants as in the framework of Crossan and Apaydin (2010), and it should be worked on in order to widen its application;

Considering I-SCORE – Innovation Scorecard for Business Excellence: (1) The tool should assess Portfolio Management activities as well as (2) Resource Allocation capabilities;

Regarding IPOO tool: (1) higher focus on the process of implementing innovation disregards several dimensions present on the framework of Crossan and Apaydin (2010) such as Leadership, Mission/Goals/Strategy, Resource Allocation, fostering of a Learning Environment.

In what concerns Determinants of Innovative Ability: (1) Low overall coincidence with the framework of Crossan and Apaydin (2010). It should be globally revised and improved.

In respect to the Community Innovation Survey: Besides having a continuous approach to the innovation evaluation process (1) Should include Innovation Leadership related assessing measures.

5.3.Limitations & Future Research

This research is not without limitations, which can open avenues for future research. First of all, not all available innovation measurement tools were compared against the framework of Crossan and Apaydin (2010); thus future research should assess other tools such as 'Improve' by Innovety or 'Innovation Audit Scorecard'. Second major limitation regards the fact that only one paper is being used as the main reference for the identification of the best innovation determinants, and as the standard for this comparative analysis.

As a remark for future research we consider it to be essential to continue to expand and develop the categories presented in the framework of Crossan and Apaydin (2010), as we identified specific patterns that might contribute for a better innovation assessment:(1) The role of leaders is usually evaluated from attitudes taken towards innovation and not their characteristics, as it happens in the framework of Crossan and Apaydin (2010); (2) The framework should regard the importance of including external focus is strategic formulation; (3) The framework lacks emphasis on financial outcomes and controls for innovation; (4) The framework of Crossan and Apaydin (2010) should regard the presence of protection mechanisms as a determinant and (5) The framework should consider Human Resource Management as a relevant concern for innovation.

As a continuity of this work, and based on the recommendations previously made considering the framework of Crossan and Apaydin (2010) and the tools analyzed, we believe the scientific

innovation community should gather efforts in order to develop a widely accepted innovation evaluation tool, as what is in stake is the survival and profitability of businesses worldwide.

5.4. Conclusion

The innovation literature is quite diverse and inconsistent. Even though innovation is a major concern of companies and governments worldwide, there is no universal concept of what it means to "be innovative" nor on how to "measure innovation". Therefore, we wanted to contribute to this scientific field, by performing a comparative analysis between what the literature states to be the right determinants for innovation measurement (represented in a systematic review of literature review performed by Crossan and Apaydin (2010)) and what the companies are using to measure innovation. After performing our comparative analysis, we came to conclude that even though some tools, like Innovation Scoring, represent a high level of completeness when comparing it against the framework of Crossan and Apaydin (2010), there is still room for improvement both in the literature and in the development of innovation measurement tools. Innovation is about applying the right and scarce resources to the right activities. The scientific community needs to gather and commit to solving the mismatch between the literature and innovation measurement tools.

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Appendices

Determinants of Innovation		
Leadership	**Managerial Levers**	**Business Processes**
Individual-level leadership characteristics	Mission, Goals and Strategy	Initiation and Decision-Making Capabilities
	Structure and Systems	Portfolio Management
Group level and Top Management team characteristics	Resource Allocation	Development and Implementation
	Organizational Learning and Knowledge Management	Project Management
	Organizational Culture	Commercialization

Appendix 1- Determinants of Innovation identified by Crossan and Apaydin (2010)

		Determinants of innovation	Tool 1	Tool 2	Tool 3	Tool 4	Tool 5	Tool 6
Innovation leadership	Individual Level (CEO)	**Tolerance to ambiguity**	X					
		Self-confidence						
		Openness to experience	X				X	
		Unconventionality						
		Originality	X					
		Rule Governess	X					
		Authoritarianism		X				
		Independence						
		Proactivity	X		X			
		Intrinsic (versus extrinsic) attribution bias						
		Determination to succeed	X		X			
		Personal initiative	X		X			
		Managerial tolerance to change	X				X	
	Top management team (TMT)	**Amount of education**						
		Age						
		Tenure						
		Diversity of Background and Experience				X		
		Extra-industry ties	X		X			
	Board governance	**Board diversity in terms of occupational background**						
		Institutional shareholding						
		Executive Stock option						

Appendix 2 - Comparative Analysis: Innovation Leadership determinants. (Tool 1: Measuring Innovation by Cotec; Tool 2: Taking the measure of your innovation performance by Bain & Company; Tool 3: I-Score, Innovation scorecard for business excellence; Tool 4 – Input-Process-Output-Outcome Model (IPOO); Tool 5: Determinants of Innovative Ability; Tool 6: Community Innovation survey.)

			Tool 1		Tool 2		Tool 3		Tool 4		Tool 5		Tool 6	
Determinants of innovation														
Managerial Levers	Missions, Goals strategies	**Prospector**	X	X		X		X				X		X
		Organic	X		X		X							
	Resource allocation	**Absolute and relative R&D Intensity**	X	X	X	X		X					X	X
		Commitment to differentiated funding	X		X								X	
		Annual turnover of resources	X											
		Slack resources	X											
	Structure and System factors	**Organization complexity**	X			X								
		Admnistrative intensity												
		Specialization and centralization									X			
		Formalization									X			
		Stratification				X					X			
		Matrix principles												
		Fit between organizational design and type of innovation	X				X							
		Number of employees												
	Learning environment fostered by	**Support for experimentation**	X	X		X	X	X				X		X
		Tolerance of failed ideas	X				X		X		X			
		Adopting risk taking norms	X								X			
		Supporting learning and development of the employees	X		X		X						X	
		Fostering the acceptance of diversity within the group	X		X		X				X		X	
	Knowledge management systems	**Usage of formal idea generation tools**	X	X	X		X	X				X		X
		External linkages with universities											X	
		Quality of the linkages with universities		X				X		X		X	X	
		Formal information gathering	X				X		X				X	
		Customer contact and frequency	X		X				X				X	
	Organizational Culture	**Having a clearly stated attainable, valuable shared vision**	X	X	X	X	X	X			X	X		
		Promoting autonomy	X		X		X				X			
		Calculating risk Taking	X		X		X				X			
		Motivation					X							
	Organizational climate attractiveness	**Organizational climate scales**						X						
		Evaluating Job satisfaction and group cohesiveness												
		Number of applicants, and age of scientists and engineers												

Appendix 3 - Comparative Analysis: Innovation Managerial Levers. (Tool 1: Measuring Innovation by Cotec; Tool 2: Taking the measure of your innovation performance by Bain & Company; Tool 3: I-Score, Innovation scorecard for business excellence; Tool 4: Input-Process-Output-Outcome Model (IPOO); Tool 5: Determinants of Innovative Ability; Tool 6: Community Innovation survey.)

			Tool 1		Tool 2		Tool 3		Tool 4		Tool 5		Tool 6	
Determinants of innovation														
Business Processes	Initiation	**awareness and attitude towards new ideas**	X	X	X	X	X	X	X	X				X
		Concept generation	X				X							
	Portfolio Management	**Consideration of risk-return balance such as ROI**	X			X					X		X	X
		Constrained optimization to maximize output												
		Economic and benefit models	X											
		Usage of optimization tools			X	X								
		Formalized process of project selection											X	
		Project selection efficiency											X	
		Evaluation of Post-hoc project results	X										X	
	Implementation	**Trials and production**	X	X	X	X		X						
	Project management	**Usage of project management tools, such as problem finding cycle**		X		X		X		X		X		
		Certified processes	X				X							
		Post-launch evaluations					X							
		Maintaining internal and external communications	X		X	X	X	X		X		X		
		Collaboration with the team	X				X				X			
		Collaboration with customers	X		X		X				X			
		Collaboration with suppliers	X				X				X			
	Project efficiency	**Innovation speed (Absolute and relative to the schedule)**		X	X	X				X				
		Project Duration			X									
	Commercialization	**Market research**	X	X		X		X		X	X		X	X
		Budget for market testing	X				X							
		Marketing proficiency, such as the number of products launched					X		X				X	
		Launch proficiency	X		X		X		X				X	
		Personnel proficiency												
		Post-launch reviews	X		X		X		X					
		Adherence to schedule												

Appendix 4 - Comparative Analysis: Innovation Business Processes. (Tool 1: Measuring Innovation by Cotec; Tool 2: Taking the measure of your innovation performance by Bain & Company; Tool 3: I-Score, Innovation scorecard for business excellence; Tool 4: Input-Process-Output-Outcome Model (IPOO); Tool 5: Determinants of Innovative Ability; Tool 6: Community Innovation survey.)